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Lab. Project 5046-3, Part 31
Final Report
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MATERIAL LABORATORY

NEW YORK NAVAL SHIPYARD
BROOKLYN 1, N. Y.

TECHNICAL REPORT

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3ND-NYNS-900-P-1

S E C U R I T Y   I N F O R M A T I O N

CRITICAL THERMAL ENERGIES

of

DOPED FABRICS

Submitted by
THE WRIGHT AIR DEVELOPMENT CENTER
Dept. of the Air Force

L. Banet
J. Bracciaventi

Lab. Project 5046-3, Part 31
Final Report
NS 081-001
Technical Objective AW-7
AFSWP-389

24 June 1953

Optics and Nucleonics Branch
J. M. McGreevy

Superintending Engineer
G.J. DASHEFSKY

The Director
CAPT. H.T. KOONCE, USN

MATERIAL LABORATORY
New York Naval Shipyard
Brooklyn 1, New York

S E C U R I T Y   I N F O R M A T I O N

Lab. Project 5046-3 Part 31
Final Report

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ABSTRACT

For the purpose of evaluating the resistance of doped fabrics to the thermal radiation of atomic explosions, the critical thermal energies of several doped fabric assemblies submitted by the Wright Air Development Center, Department of the Air Force, were determined by exposing the materials to the Laboratory carbon-arc source of thermal radiation and examining the consequent damage.

The carbon arc source furnishes a maximum irradiance of 85 cal/cm^2/sec in the central area of the specimens if no absorbing screens were employed. However, However, for a better approximation of the Laboratory exposure time to that obtained in the field, absorbing screens were employed, giving effective exposure times between 0.3 and 0.6 seconds. The methods of exposure and evaluation of the effective damage are indicated. It was found that the assemblies suffered complete destruction at radiant exposures ranging from 4.9 to 213 cal/cm^2, depending on the assembly exposed. Assemblies employing metal foils had considerably higher critical energies of destruction (55 to 213 cal/cm^2) than the other experimental assemblies investigated, (4.9 to 20 cal/cm^2).

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Ref: (a) COMNYKNAVSHIPYD ltr C-S99/L5, Ser C-960-92 of 14 Mar 1950
(b) BUSHIPS restr spdltr S99-(0)(348) Ser 348-75 of 6 Apr 1950

Encl: (1) Critical Thermal Energies of Doped Fabrics

AUTHORITY

1. This investigation is part of the program proposed by reference (a) and formally authorized by reference (b). The general Thermal Radiation Program is under the supervision of the Armed Forces Special Weapons Project.

INTRODUCTION

2. As part of its general program on the effects of the thermal radiation of atomic explosions on materials, the Naval Material Laboratory is evaluating the characteristics, under exposure to thermal radiation, of the various materials of particular interest to the several agencies of the Department of Defense. As data become available, these findings are published. In this report, the critical thermal energies of doped fabrics, submitted by the Wright Air Development Center, Department of the Air Force, are indicated.

EQUIPMENT AND METHODS OF EXPOSURE

3. The critical thermal energies of the doped fabrics were determined, employing the Material Laboratory carbon-arc source of thermal radiation (Bibliography 1,2,3,4). The source consists of an 11-mm carbon arc, mounted at the focus of a mirror which collimates the emitted energy. A second mirror, which is mounted coaxially at a distance of 12 feet from the collimator, condenses the radiation to the mirror's focus. Gradations of thermal damage are obtained by varying the effective exposure time by accelerating a sample, 1 x 8 inches in surface dimensions, moving transversely through the focus. Except for the last two of the specimens, the exposure of the materials was made by fastening them to glass melamine blocks provided with cut-outs in the central area to furnish an air background. In order to reduce propagation of flame during exposure and in order to secure the specimens to the glass melamine block serving as a base, a glass silicone mask with several stops was used over the fabrics.

RESULTS

4. The critical thermal energies of the doped fabrics, submitted by the Wright Air Development Center, were defined as those which produce certain characteristic, reproducible effects on the materials, such as

destruction, blistering or ignition. These exposures were obtained with a carbon-arc source which furnished a maximum irradiance of 85 cal/cm^2/sec in the central area of the specimens, if no absorbing screens were employed. However, for a better approximation of the laboratory exposure time to that obtained in the field, absorbing screens were employed, giving effective exposure times of 300 to 600 milliseconds. The critical energies are given on enclosure (1).

5. It may be noted that the laboratory exposures have been produced under highly controlled conditions and, as a rule, give results which can be reproduced very well. However, for several reasons, one must use the data of enclosure (1) with caution. The effects to be observed on material samples frequently remain unchanged over a considerable range of exposures. Since the surface effects are not gradated sufficiently for refined evaluations, only the initial stages have been recorded. The effects on material surfaces are influenced by such factors as mounting, uniformity of material, atmospheric conditions and moisture content. Differences in density, absorption coefficient, chemical composition and particle size are responsible for the variations in effects which may be observed from area to area on the same material. Liquids and gases form during exposure to thermal radiation, even in a period of less than one second, thereby affecting the amount of thermal radiation incident on and absorbed by the surface.

SUMMARY

6. The results of this investigation indicate that upon irradiation by the Material Laboratory carbon-arc source of thermal radiation for exposure times of 300-600 milliseconds, the doped fabric assemblies, submitted by the Wright Air Development Center, suffered destruction at radiant exposures ranging from 4.9 to 146 cal/cm^2, depending upon the assembly exposed; the metallic, vinyl coated specimen was destroyed at 213 cal/cm^2. However, there was a marked difference between the fabric assemblies with and without metal foils. Assemblies without metal foils were destroyed at exposures ranging from 4.9 to 20 cal/cm^2, but doped fabrics with metal foils suffered destruction at radiant exposures as high as 55 to 146 cal/cm^2, depending on the specific assembly employed.

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BIBLIOGRAPHY

1. Material Laboratory, New York Naval Shipyard. Determination of Intensity Distribution at the Focus of a Parabolic Mirror and the Energy Density on a Moving Surface, using a Tungsten Lamp Source. Report No. 5046, Part 5 (July 1949).

2. Material Laboratory, New York Naval Shipyard. Evaluation of Thermal Effects on Specimens Exposed at Bikini. Report No. 5046, Part 7 (March 1950).

3. Material Laboratory, New York Naval Shipyard. A Method of Measuring High Intensities at the Focus of a Parabolic Reflector with Large Relative Aperture. Report No. 5046, Part 3 (November 1948.)

4. Material Laboratory, New York Naval Shipyard. Critical Thermal Energies of Clothing Materials, Submitted by the U.S. Marine Corps. Report No. 5046-3, Part 3 (July 1951).

Approved:

H. T. Koonce

H. T. KOONCE, CAPTAIN, USN
The Director

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Critical Thermal Energies
of Experimental Dope Systems
Submitted by
The Wright Air Development Center
(Exposures of 300 to 600 Milliseconds)

WADC Designation	Materials and Treatment	Description of Effect	C.E. cal/cm^2
A	2 Spray coats MIL-D-5552 Dope (Aluminum pigment 6 oz/gal) on Standard Doped Fabric Finish, consisting of 2 brush coats and 2 spray coats MIL-D-5553 Cellulose Nitrate Dope	Destruction by propagating flame and afterglow	4.9
B	1 Spray coat (1 mil) Silicone coating on Standard Doped Fabric Finish (as in "A")	Dulling of Surface	4.9-6.2
		Surface blisters, fabric chars through	11
		Destruction by propagating flame and afterglow	13
C	2 Spray coats (1 1/2 mil) vinyl coating on Standard Doped Fabric Finish	Paint carbonized by slowly propagating flame, leaving tumescent but flimsy ash, fabric chars through, but not completely destroyed	4.9
		Destruction of fabric by afterglow	12
D	1 Spray coat (1 mil) MIL-V-6893 varnish on Standard Doped Fabric Finish	Surface blisters	7.3-8.0
		Surface coat destroyed by slowly propagating flame, fabric chars through, but not completely destroyed	9.1
		Destruction of fabric by afterglow	15
E	Aluminum foil (0.0015") on 1 Spray coat MIL-C-4003 (1 mil) on Standard Doped Fabric Finish	Flames sporadically, foil melts sporadically, fabric backing chars through	56-63

Critical Thermal Energies
of Experimental Dope Systems
Submitted By
The Wright Air Development Center
(Exposures of 300-to 600 Milliseconds)

WADC Designation	Materials and Treatment	Description of Effect	C.E. cal/cm^2
F	Aluminum foil (0.0025") on 1 Spray coat MIL-C-4003 (1 mil) on Standard Doped Fabric Finish	Flames sporadically, foil melts sporadically, fabric backing chars through	146
G	Aluminum foil (0.0025") on 1 Spray coat MIL-C-4003 Cement (1/4 mil) on Standard Doped Fabric Finish	Flames sporadically, foil melts sporadically, fabric backing chars through	56
H	2 Spray coats MIL-D-5552 Dope (Aluminum pigment 6.0 oz/gal) on 2 brush coats and 2 spray coats MIL-D-5549 Cellulose Acetate Butyrate Dope	Dulling of surface	3.7
		Fabric chars	6.6
		Destruction of fabric by slowly propagating flame	18-20
I	Aluminum foil (0.0015") on 1 spray coat MIL-C-4003 cement (1 mil) on CAB Doped Fabric	Flames sporadically, foil melts sporadically, fabric backing chars through, dense smoke evolved	112
J	Vinyl coating (as in C) on 1 dip coat and 1 spray coat MIL-P-6889 Zinc Chromate Primer on 0.016" anodized magnesium (CVAC #1)	Surface chars	18
		Flames during exposure	31
		Paint completely carbonized, base metal exposed on slight scraping	49
		Metal completely destroyed by violent reaction, leaving powdery ash	213
K	1 Spray coat of white gloss enamel (Specif. MIL-E-7729) over assembly of "A"	Paint forms soft blisters and chars	7.5
		Fabric chars through	16
		Destruction of fabric by slowly propagating flame	19

Critical Thermal Energies
of Experimental Dope Systems
Submitted By
The Wright Air Development Center
(Exposures of 300 to 600 Milliseconds)

WADC Designation	Materials and Treatment	Description of Effect	C.E. cal/cm^2
(None) NML #1	Aluminum (3 mil, painted) over doped fabric, mounted on 4" metal shell (5 walls)	Charring and blistering of paint	14
		Paint destroyed	24-27
		Surface flames during exposure	34
		Charring and destruction of fabric under metal foil	37-54
		Melting of metal foil	55-62
(None) NML #2	Aluminum (3 mil, unpainted) over doped fabric, mounted on 4" metal shells (5 walls)	Charring of fabric under metal foil	40-64
		Destruction of fabric under metal foil	66-108
		Flame development during exposure	108
		Sporadic melting of metal foil	94-123

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